

Interface Control Document (ICD)
Between the
Flight Dynamics Facility (FDF)
and the GLAST
Mission Operations Center (MOC)

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REVISION STATUS

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1 INTRODUCTION

1.1 PURPOSE

This Interface Control Document (ICD) defines the interfaces, formats, schedules, and procedures for delivering products between the Flight Dynamics Facility (FDF) and the GLAST Mission Operations Center (MOC), located at NASA GSFC.

1.2 SCOPE

This document governs the technical interfaces, product deliveries, and protocols between the FDF and the MOC. Specific message and data product examples are included in the appendices.

1.3 DOCUMENTATION

The interfaces defined in this ICD were derived from high-level requirements contained in the following sources:

- *GLAST Ground Systems Requirements Document*, GSFC-443-RQMT-006, October 15, 2003.
- *GLAST MOC Functional & Performance Requirements Document*, 492-MOC-002, Version 0.01, December 4, 2003.
- *GLAST Project Service Level Agreement*, 451-PSLA-GLAST, January 2004.

2 FACILITIES OVERVIEW

2.1 FDF DESCRIPTION

The Flight Dynamics Facility (FDF) resides in GSFC Building 28. FDF capabilities include orbit determination, metric tracking data evaluation, and launch vehicle support. FDF support will be primarily during launch, spacecraft checkout, and during orbit contingencies (i.e., GPS outage). Detailed FDF support for the GLAST mission is provided in the document 451-PSLA-GLAST.

2.2 MOC DESCRIPTION

The Mission Operations Center (MOC) resides in GSFC Building 14. MOC capabilities include mission planning, scheduling, telemetry and command processing, mission monitoring, offline processing, trending and analysis. The Flight Dynamics System (FDS) is a component of the MOC. The FDS provides flight dynamics planning and scheduling capabilities to the FOT. These capabilities include orbit prediction, attitude prediction, product generation, and acquisition data generation.

The Attitude Determination System (ADS) resides in the MOC. The ADS provides non-real-time attitude determination and sensor calibration capabilities. The ADS software will be provided by Code 595 and operates on a Windows-based PC workstation.

2.3 DATA INTERFACE

The data interface for the FDF, MOC, and external elements is depicted in Figure 2-1.

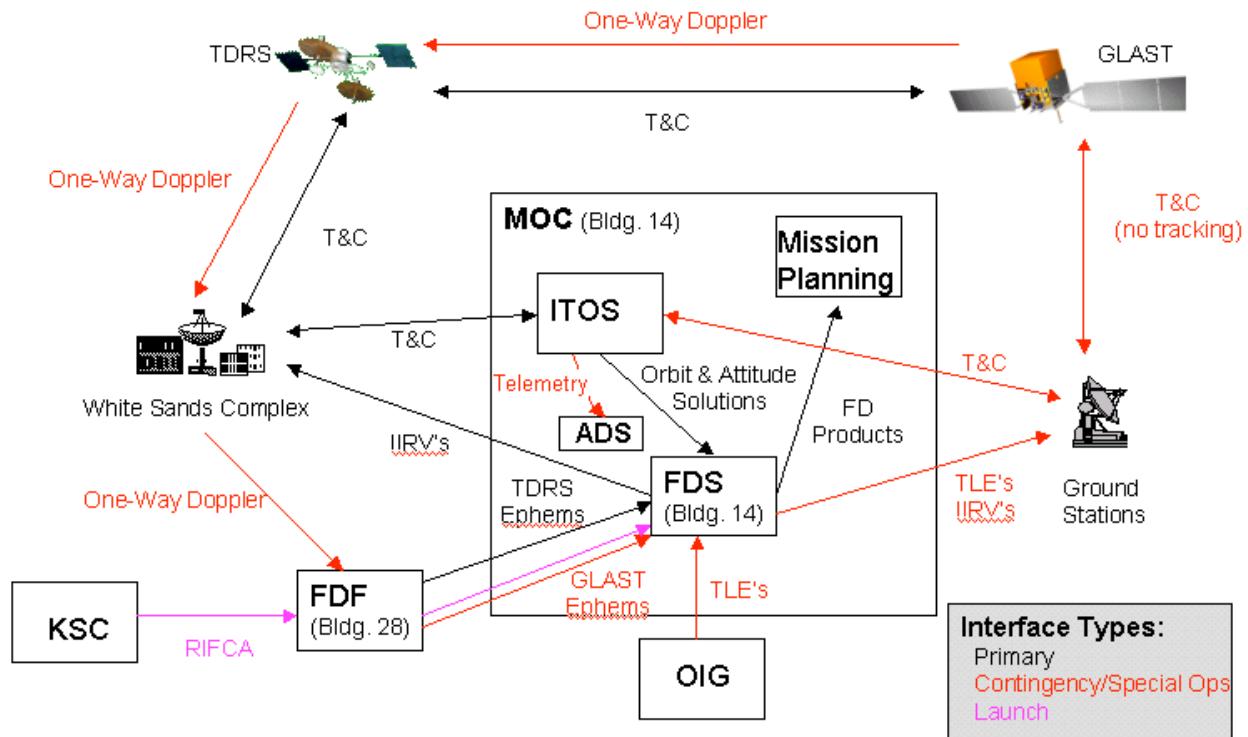


Figure 2-1: GLAST Flight Dynamics Data Flow Diagram

3 PRODUCTS AND FORMATS

Table 3-1 summarizes all of the flight dynamics products transferred between the FDF and the MOC. Appendix A provides samples of each product. The following subsections provide more detail on each product's content and attributes.

Table 3-1: Flight Dynamics Data Products

Product	Contents	Timespan	From/To	Delivery Rate	Size	Mission Phase
Predictive GLAST Orbit Ephemerides	GLAST Spacecraft time, position, velocity	21 days	FDF/MOC	TBS	172 Kbytes	Post-Separation, L&EO
Definitive GLAST Orbit Ephemerides	GLAST Spacecraft time, position, velocity	3 days	FDF/MOC	TBS	25 Kbytes	During GPS Contingencies
Predictive TDRSS Orbit Ephemerides	TDRS Spacecraft time, position, velocity	21 days	FDF/MOC	TBS	172 Kbytes	Entire Mission
Telemetry Files	Attitude & Orbit Telemetry Data	TBS	MOC/FDS	TBS	TBS	During Attitude & Instrument Calibration

The coordinate system and reference frame used for all products is Earth-Centered Inertial (ECI) J2000, unless otherwise stated.

All times are in Universal Time Coordinated (UTC), unless otherwise stated.

3.1 PREDICTIVE GLAST ORBIT EPHEMERIS

FDF shall provide the MOC with predictive GLAST orbit ephemeris files.

3.1.1 Data Format

The data format will comply with the STK EphemerisTimePosVel format.

3.1.2 File Name Format

TDRSid_EPH_yyyyddd_yyyyddd_vv.e

where *TDRS_{id}* is the TDRS ID: TDE, TDW, TDS, etc
yyyy is the 4-digit year
ddd is the 3-digit day of the year (001 – 366)
vv is a version number

The two dates indicate the start and end dates of the ephemeris data contained in the file.

The version number (initial version is 00) is incremented for subsequent versions of the file generated for the same time range of data.

Example:
TDE_EPH_2003202_2003214_00.e

3.1.3 Data Transfer Mechanism

Secure Shell File Transfer Protocol (sftp) will be used.

3.2 DEFINITIVE GLAST ORBIT EPHEMERIS

FDF shall provide the MOC with definitive GLAST orbit ephemeris files. These files will be provided only in the event of a long-term (3 days or more) GPS data loss. These files will in turn be provided to the Science Instrument Operations Centers (SIOCs).

3.2.1 Data Format

The data format will comply with the STK EphemerisTimePosVel format.

3.2.2 File Name Format

GLAST_EPH_DEF_yyyyddd_yyyymm_dd_vv.e

where *yyyy* is the 4-digit year
ddd is the 3-digit day of the year (001 – 366)
vv is a version number

The two dates indicate the start and end dates of the ephemeris data contained in the file.

The version number (initial version is 00) is incremented for subsequent versions of the file generated for the same time range of data.

Example:
GLAST_EPH_DEF_2003202_2003214_00.e

3.2.3 Data Transfer Mechanism

Secure Shell File Transfer Protocol (sftp) will be used.

3.3 PREDICTIVE TDRSS ORBIT EPHEMERIS

FDF shall provide the MOC with predictive TDRS orbit ephemeris files.

3.3.1 Data Format

The data format will comply with the STK EphemerisTimePosVel format.

3.3.2 File Name Format

GLAST_EPH_PRE_yyyyddd_yyyyddd_vv.e

where *yyyy* is the 4-digit year
ddd is the 3-digit day of the year (001 – 366)
vv is a version number

The two dates indicate the start and end dates of the ephemeris data contained in the file.

The version number (initial version is 00) is incremented for subsequent versions of the file generated for the same time range of data.

Example:

GLAST_EPH_PRE_2003202_2003214_00.e

3.3.3 Data Transfer Mechanism

Secure Shell File Transfer Protocol (sftp) will be used.

3.4 TELEMETRY FILES

MOC shall provide the FDS with attitude and orbit telemetry data files. The files will include telemetry mnemonics for star tracker (ST), scalable inertial reference unit (SIRU), and GPS data.

3.4.1 Data Format

Telemetry files will be delivered in the format of ITOS sequential print files. This format is defined in the *ITOS Page & Seqprt Definition Guide* (<http://itos.gsfc.nasa.gov/itos7-3/htdocs/itos-display.pdf>) and <http://itos.gsfc.nasa.gov/itos7-3/htdocs/filtersp.pdf>. The general format of a sequential print file is as follows:

```
TIME, MNEMONIC1, MNEMONIC2, MNEMONIC3, MNEMONIC4, MNEMONIC5, MNEMONIC6,  
YYYY-DDD-HH:MM:SS.mmmmmm, aa.aaaaaaaa, bb.bbbbbbb, cc.ccccccc, dd.ddddddd, ee.eeeeeee, ff.fffffff,  
YYYY-DDD-HH:MM:SS.mmmmmm, aa.aaaaaaaa, bb.bbbbbbb, cc.ccccccc, dd.ddddddd, ee.eeeeeee, ff.fffffff,
```

3.4.2 File Name Format

TBS

3.4.3 Data Transfer Mechanism

Secure Shell File Transfer Protocol (sftp) will be used.

APPENDIX A: Product Examples

A.1 Orbit Ephemeris Product Example

```
stk.v.4.3

BEGIN Ephemeris

NumberOfEphemerisPoints 16

ScenarioEpoch           19 Mar 2004 00:00:00.000000000
InterpolationMethod     Lagrange
InterpolationOrder      7
CentralBody              Earth
CoordinateSystem          J2000

EphemerisTimePosVel

0.000000000000e+000 -6.15327153548144e+006 2.99473202126458e+006
1.21184078274152e+006 -3.49621903129823e+003 -5.81937940172753e+003 -
3.35947749012211e+003
8.64000000000000e+004 -6.29224223557850e+006 2.86326893746003e+006
7.19927177082109e+005 -3.10882307448791e+003 -5.94034029642589e+003 -
3.52341538895409e+003
1.72800000000000e+005 -6.39097547686909e+006 2.72566347301095e+006
2.10182074130897e+005 -2.71556426214994e+003 -6.08337956288373e+003 -
3.60218507982767e+003
2.59200000000000e+005 -6.45032184975768e+006 2.57428655126923e+006 -
3.05073040641206e+005 -2.32571059725353e+003 -6.24687260956778e+003 -
3.59368720323219e+003
3.45600000000000e+005 -6.47326110613807e+006 2.40210799864975e+006 -
8.1333330308132e+005 -1.94788725249140e+003 -6.42693260572684e+003 -
3.49795005784390e+003
4.32000000000000e+005 -6.46466486097237e+006 2.20326350613575e+006 -
1.30220597668239e+006 -1.58951248728859e+003 -6.61765353824940e+003 -
3.31713849335608e+003
5.18400000000000e+005 -6.43094075234765e+006 1.97349267547756e+006 -
1.75973107892082e+006 -1.25626119243512e+003 -6.81152114356932e+003 -
3.05551040469724e+003
6.04800000000000e+005 -6.37955955462846e+006 1.71045311042918e+006 -
2.1746878496375e+006 -9.51651257859870e+002 -6.99994215645162e+003 -
2.71929995085232e+003
6.91200000000000e+005 -6.31848633216296e+006 1.41396466945354e+006 -
2.53684933435175e+006 -6.76864133149495e+002 -7.17383480417756e+003 -
2.31656931479039e+003
7.77600000000000e+005 -6.25558002052202e+006 1.08609225130134e+006 -
2.83723122192689e+006 -4.30715104243749e+002 -7.32427137193341e+003 -
1.85703327522433e+003
8.64000000000000e+005 -6.19801140688751e+006 7.30995982857514e+005 -
3.06833894885173e+006 -2.09723244961161e+002 -7.44312371990083e+003 -
1.35181495620263e+003
```

```
9.50400000000000e+005 -6.15173102245719e+006 3.54650499460301e+005 -
3.22435690455210e+006 -8.38580522112613e+000 -7.52363223484332e+003 -
8.13166080330663e+002
1.03680000000000e+006 -6.12102243374152e+006 -3.55201003017011e+004 -
3.30128597418137e+006 1.80352704413353e+002 -7.56087671009529e+003 -
2.54186778133173e+002
1.12320000000000e+006 -6.10817417161159e+006 -4.31152507389422e+005 -
3.29704946474003e+006 3.64566151724840e+002 -7.55213057059984e+003
3.11489358625394e+002
1.20960000000000e+006 -6.11329916677434e+006 -8.23531623306221e+005 -
3.21154849614584e+006 5.52746502243409e+002 -7.49704987841244e+003
8.70026046697429e+002
1.29600000000000e+006 -6.13431868094360e+006 -1.20414726342447e+006 -
3.04667407210567e+006 7.53111062241963e+002 -7.39769505982899e+003
1.40768719152938e+003
```

END Ephemeris

A.2 Telemetry File Example

TBS

ACRONYM LIST

ECI	Earth-Centered Inertial
FDF	Flight Dynamics Facility
FDS	Flight Dynamics System
FOT	Flight Operations Team
GLAST	Gamma Ray Large Area Telescope
GN	Ground Network
GPS	Global Positioning System
GSFC	Goddard Space Flight Center
ICD	Interface Control Document
IIRV	Improved Interrange Vector
ITOS	Integrated Test and Operations System
KSC	Kennedy Space Center
L&EO	Launch and Early Orbit
MOC	Mission Operations Center
MPS	Mission Planning System
NASA	National Aeronautics and Space Administration
NORAD	North American Aerospace Defense Command
OIG	Orbit Information Group
PSLA	Project Service Level Agreement
RIFCA	Redundant Inertial Flight Control Assembly
sftp	Secure Shell File Transfer Protocol
SIOC	Science Instrument Operations Center
SIRU	Scalable Inertial Reference Unit
SN	Space Network
ST	Star Tracker
STK	Satellite Tool Kit
TBS	To Be Supplied
TDRS	Tracking and Data Relay Satellite
TLE	Two-Line Element
WSC	White Sands Complex